CLAIMS

[c1] 1. A system for controlling a mechanical or chemical-mechanical planarizing machine that planarizes microelectronic substrates, comprising:

a light system having a light source comprising at least a first emitter that generates a first light pulse having a first color and a second emitter that generates a second light pulse having a second color different than the first color, wherein the light source is configured to direct the first and second light pulses toward a front surface of a microelectronic substrate in a manner that creates a first return light pulse corresponding to a reflectance of the first light pulse and a second return light pulse corresponding to a reflectance of the second light pulse;

a sensor configured to receive the first return light pulse and the second return light pulse, the sensor being capable of generating a first measured intensity of the first return light pulse and a second measured intensity of the second return light pulse; and

a computer coupled to the sensor, the computer having a database and a computer readable medium, the database containing a plurality of sets of reference reflectances in which each set has a first reference component defined by a reflectance intensity of the first light pulse and a second reference component defined by a reflectance intensity of the second light pulse from a selected surface level in a layer of material on the microelectronic substrate, and the computer readable medium containing a computer readable program that causes the computer to control a parameter of the planarizing machine when the first and second measured intensities correspond to the first and second reference components of a selected reference reflectance set.

[c2] 2. The system of claim 1 wherein:

the database includes an endpoint reference reflectance set having a first reference component corresponding to a first endpoint intensity of the first return light pulse from an endpoint surface and a second reference component corresponding to a second endpoint intensity of the second return light pulse from the endpoint surface; and

the computer readable program causes the computer to terminate a planarizing cycle when the first and second measured intensities correspond to the first and second endpoint intensities, respectively.

[c3] 3. The system of claim 1 wherein:

the first emitter comprises a red LED that generates a red first light pulse having a wavelength of approximately 600 nm to 780 nm; and

the second emitter comprises a green LED that generates a green second light pulse having a wavelength of approximately 490 nm to 577 nm.

[c4] 4. The system of claim 1 wherein the sensor includes a single photo detector that measures both the first intensity of the first return light pulse and the second intensity of the second return light pulse.

[c5] 5. The system of claim 1 wherein the light source further comprises a third emitter that generates a third light pulse having a third color different than the first and second colors.

[c6] 6. The system of claim 5 wherein:

the first emitter comprises a red LED that generates a red first light pulse having a wavelength of approximately 600 nm to 780 nm and a red first return light pulse;

the second emitter comprises a green LED that generates a green second light pulse having a wavelength of approximately 490 nm to 577 nm and a green second return light pulse; and

the third emitter comprises a blue LED that generates a blue third light pulse having a wavelength of approximately 450 nm to 490 nm and a blue third return light pulse.

[c7] 7. The system of claim 6 wherein the sensor comprises a single photo detector that measures the first intensity of the red first return light pulse, the second intensity of the green second return light pulse, and a third intensity of the blue third return light pulse.

[c8] 8. The system of claim 6 wherein:

the database includes an endpoint reference reflectance set having a first reference component corresponding to a first endpoint intensity of the red first return light pulse from an endpoint surface, a second endpoint component corresponding to a second endpoint intensity of the green second return light pulse from the endpoint surface, and a third reference component corresponding to a third endpoint intensity of the blue third return light pulse from the endpoint surface; and

the computer readable program causes the computer to terminate a planarizing cycle when the first, second and third measured intensities correspond to the first, second and third endpoint intensities, respectively.

[c9] 9. The system of claim 6 wherein:

the database includes a reference reflectance set corresponding to an interface between two layers of material on a substrate, wherein the reference set has a first reference component corresponding to a

first interface intensity of the red first return light pulse from an interface surface, a second reference component corresponding to a second interface intensity of the green second return light pulse from the interface surface, and a third reference component corresponding to a third interface intensity of the blue third return light pulse from the interface surface; and

the computer readable program causes the computer to indicate when the first, second and third measured intensities correspond to the first, second and third interface intensities, respectively.

[c10] 10. A system for endpointing a mechanical or chemical-mechanical planarizing machine that planarizes microelectronic substrates, comprising:

a light source having a first emitter that emits a first light pulse having a first color and a second emitter that emits a second light pulse having a second color different than the first color, the light source being configured to direct the first light pulse and the second light pulse against a front surface of a microelectronic substrate to create a first return light pulse from the first light pulse and a second return light pulse from the second light pulse;

a light sensor having a single photo detector configured to receive the first return light pulse and the second return light pulse, wherein the photo detector measures a first intensity of the first return light pulse and a second intensity of the second return light pulse; and

a controller coupled to the light sensor, the controller changing a parameter of a planarizing cycle for the microelectronic substrate when the first and second intensities of the first and second return light pulses correspond to a set of first and second reference reflectance intensities at a selected stage of the planarizing cycle.

[c11] 11. The system of claim 10 whereon the controller comprises a computer having:

a database containing the set of first and second reference reflectance intensities at the selected stage of the planarizing cycle; and

a computer readable program that causes the computer to change a parameter of the planarizing cycle when the first and second intensities of the first and second return light pulses correspond to the set of first and second reference reflectance intensities at the selected stage.

[c12] 12. The system of claim 11 wherein:

the database includes an endpoint reference reflectance set having a first reference component corresponding to a first endpoint intensity of the first return light pulse from an endpoint surface and a second reference component corresponding to a second endpoint intensity of the second return light pulse from the endpoint surface; and

the computer readable program causes the computer to terminate a planarizing cycle when the first and second measured intensities correspond to the first and second endpoint intensities, respectively.

[c13] 13. The system of claim 10 wherein:

the first emitter comprises a red LED that generates a red first light pulse having a wavelength of approximately 600 nm to 780 nm; and

the second emitter comprises a green LED that generates a green second light pulse having a wavelength of approximately 490 nm to 577 nm.

[c14] 14. The system of claim 10 wherein the light source further comprises a third emitter that generates a third light pulse having a third color different than the first and second colors.

[c15] 15. The system of claim 14 wherein:

the first emitter comprises a red LED that generates a red first light pulse having a wavelength of approximately 600 nm to 780 nm and a red first return light pulse;

the second emitter comprises a green LED that generates a green second light pulse having a wavelength of approximately 490 nm to 577 nm and a green second return light pulse; and

the third emitter comprises a blue LED that generates a blue third light pulse having a wavelength of approximately 450 nm to 490 nm and a blue third return light pulse.

[c16] 16. The system of claim 15 wherein the single photo detector measures the first intensity of the red first return light pulse, the second intensity of the green second return light pulse, and a third intensity of the blue third return light pulse.

[c17] 17. The system of claim 15 wherein:

the database includes an endpoint reference reflectance set having a first reference component corresponding to a first endpoint intensity of the red first return light pulse from an endpoint surface, a second endpoint component corresponding to a second endpoint intensity of the green second return light pulse from the endpoint surface, and a third reference component corresponding to a third endpoint intensity of the blue third return light pulse from the endpoint surface; and

the computer readable program causes the computer to terminate a planarizing cycle when the first, second and third measured intensities correspond to the first, second and third endpoint intensities, respectively.

[c18] 18. The system of claim 15 wherein:

the database includes a reference reflectance set corresponding to an interface between two layers of material on a substrate, wherein the reference set has a first reference component corresponding to a first interface intensity of the red first return light pulse from an interface surface, a second reference component corresponding to a second interface intensity of the green second return light pulse from the interface surface, and a third reference component corresponding to a third interface intensity of the blue third return light pulse from the interface surface; and

the computer readable program causes the computer to indicate when the first, second and third measured intensities correspond to the first, second and third interface intensities, respectively.

[c19] 19. A planarizing machine for mechanical and/or chemical-mechanical planarization of a microelectronic substrate, comprising:

a table having a support surface;

a planarizing pad on the support surface of the table;

a substrate carrier assembly having a drive system and a carrier head coupled to the drive system, the carrier head being configured to hold a substrate and the drive system be capable of moving the carrier head to engage the substrate with the planarizing pad, wherein the carrier head and/or the table is movable relative to the other to rub the substrate against the planarizing pad;

a light system having a light source comprising a first emitter that generates a first light pulse having a first color and a second emitter that generates a second light pulse having a second color different than the first color, wherein the light source is configured to direct the first and second light pulses toward a front surface of a microelectronic substrate in a manner that creates a first return light

pulse corresponding to a reflectance of the first light pulse and a second return light pulse corresponding to a reflectance of the second light pulse;

a sensor configured to receive the first return light pulse and the second return light pulse, the sensor being capable of generating a first measured intensity of the first return light pulse and a second measured intensity of the second return light pulse; and

a computer coupled to the sensor, the computer having a database and a computer readable medium, the database containing a plurality of sets of reference reflectances in which each set has a first reference component defined by a reflectance intensity of the first light pulse and a second reference component defined by a reflectance intensity of the second light pulse from a selected surface level in a layer of material on the microelectronic substrate, and the computer readable medium containing a computer readable program that causes the computer to control a parameter of the planarizing machine when the first and second measured intensities correspond to the first and second reference components of a selected reference reflectance set.

[c20] 20. The planarizing machine of claim 19 wherein:

the database includes an endpoint reference reflectance set having a first reference component corresponding to a first endpoint intensity of the first return light pulse from an endpoint surface and a second reference component corresponding to a second endpoint intensity of the second return light pulse from the endpoint surface; and

the computer readable program causes the computer to terminate a planarizing cycle when the first and second measured intensities correspond to the first and second endpoint intensities, respectively.

[c21] 21. The planarizing machine of claim 19 wherein:

the first emitter comprises a red LED that generates a red first light pulse having a wavelength of approximately 600 nm to 780 nm; and

the second emitter comprises a green LED that generates a green second light pulse having a wavelength of approximately 490 nm to 577 nm.

[c22] 22. The planarizing machine of claim 19 wherein the sensor includes a single photo detector that measures both the first intensity of the first return light pulse and the second intensity of the second return light pulse.

[c23] 23. The planarizing machine of claim 19 wherein the light source further comprises a third emitter that generates a third light pulse having a third color different than the first and second colors.

[c24] 24. The planarizing machine of claim 23 wherein:

the first emitter comprises a red LED that generates a red first light pulse having a wavelength of approximately 600 nm to 780 nm and a red first return light pulse;

the second emitter comprises a green LED that generates a green second light pulse having a wavelength of approximately 490 nm to 577 nm and a green second return light pulse; and

the third emitter comprises a blue LED that generates a blue third light pulse having a wavelength of approximately 450 nm to 490 nm and a blue third return light pulse.

[c25] 25. The planarizing machine of claim 24 wherein the sensor comprises a single photo detector that measures the first intensity of the red first return light pulse, the second intensity of the green second return light pulse, and a third intensity of the blue third return light pulse.

[c26] 26. The planarizing machine of claim 24 wherein:

the database includes an endpoint reference reflectance set having a first reference component corresponding to a first endpoint intensity of the red first return light pulse from an endpoint surface, a second endpoint component corresponding to a second intensity of the green second return light pulse from the endpoint surface, and a third reference component corresponding to a third endpoint intensity of the blue third return light pulse from the endpoint surface; and

the computer readable program causes the computer to terminate a planarizing cycle when the first, second and third measured intensities correspond to the first, second and third endpoint intensities, respectively.

[c27] 27. The planarizing machine of claim 24 wherein:

the database includes a reference reflectance set corresponding to an interface between two layers of material on a substrate, wherein the reference set has a first reference component corresponding to a first interface intensity of the red first return light pulse from an interface surface, a second reference component corresponding to a second interface intensity of the green second return light pulse from the interface surface, and a third reference component corresponding to a third interface intensity of the blue third return light pulse from the interface surface; and

the computer readable program causes the computer to indicate when the first, second and third measured intensities correspond to the first, second and third interface intensities, respectively.

[c28] 28. A planarizing machine for mechanical and/or chemical-mechanical planarization of a microelectronic substrate, comprising:

a table having a support surface;

a planarizing pad on the support surface of the table, the planarizing pad having an optically transmissive window;

a substrate carrier assembly having a drive system and a carrier head coupled to the drive system, the carrier head being configured to hold a substrate and the drive system being capable of moving the carrier head to engage the substrate with the planarizing pad, wherein the carrier head and/or the table is movable relative to the other to rub the substrate against the planarizing pad;

a light system having a light source and a light sensor, the light source having a first emitter that emits a first light pulse having a first color and a second emitter that emits a second light pulse having a second color different than the first color, the light source being configured to direct the first and second light pulses through the window in the planarizing pad and against a front surface of a microelectronic substrate in a matter that creates a first return light pulse from the first light pulse and a second return light pulse from the second light pulse, the light sensor having a single photo detector configured to receive the first return light pulse and the second return light pulse, and the photo detector being capable of measuring both a first intensity of the first return light pulse and a second intensity of the second return light pulse; and

a controller coupled to the sensor, the controller controlling a parameter of planarizing the microelectronic substrate according to the first and second intensities of the first and second return light pulses measured by the photocell.

[c29] 29. The planarizing machine of claim 28 wherein the controller comprises a computer having:

a database containing an endpoint reference reflectance set having a first reference component corresponding to a first endpoint intensity of a reflectance of the first light pulse from an endpoint surface and a second reference component corresponding to a second endpoint intensity of the second light pulse from the endpoint surface; and

a computer readable program that causes the computer to terminate a planarizing cycle when the first and second measured intensities correspond to the first and second endpoint intensities, respectively.

[c30] 30. The planarizing machine of claim 28 wherein:

the first emitter comprises a red LED that generates a red first light pulse having a wavelength of approximately 600 nm to 780 nm; and

the second emitter comprises a green LED that generates a green second light pulse having a wavelength of approximately 490 nm to 577 nm.

[c31] 31. The planarizing machine of claim 28 wherein the light source further comprises a third emitter that generates a third light pulse having a third color different than the first and second colors.

[c32] 32. The planarizing machine of claim 31 wherein:

the first emitter comprises a red LED that generates a red first light pulse having a wavelength of approximately 600 nm to 780 nm and a red first return light pulse;

the second emitter comprises a green LED that generates a green second light pulse having a wavelength of approximately 490 nm to 577 nm and a green second return light pulse; and

the third emitter comprises a blue LED that generates a blue third light pulse having a wavelength of approximately 450 nm to 490 nm and a blue third return light pulse.

[c33] 33. The planarizing machine of claim 32 wherein the single photo detector measures the first red intensity of the first return light pulse, the second green intensity of the second return light pulse, and a third intensity of the blue third return light pulse.

[c34] 34. The planarizing machine of claim 32 wherein the controller comprises a computer having:

a database including an endpoint reference reflectance set having a first reference component corresponding to a first endpoint intensity of a reflectance of the red first light pulse from an endpoint surface, a second reference component corresponding to a second endpoint intensity of the green second light pulse from the endpoint surface, and a third reference component corresponding to a third endpoint intensity of a reflectance of the blue third light pulse from the endpoint surface; and

a computer readable program that causes the computer to terminate a planarizing cycle when the first, second and third measured intensities correspond to the first, second and third endpoint intensities, respectively.

[c35] 35. The planarizing machine of claim 32 wherein the controller comprises a computer having:

a database containing a reference reflectance set corresponding to an interface between two layers of material on a substrate, wherein the reference set has a first reference component corresponding to a first interface intensity of a reflectance of the red first light pulse from

an interface surface, a second reference component corresponding to a second interface intensity of the green second light pulse from the interface surface, and a third reference component corresponding to a third interface intensity of a reflectance of the blue third light pulse from the interface surface; and

a computer readable program that causes the computer to indicate when the first, second and third measured intensities correspond to the first, second and third interface intensities, respectively.

[c36] 36. A method of planarizing a microelectronic device substrate, comprising:

contacting a face of the microelectronic device substrate with a planarizing surface of a planarizing pad;

moving the substrate and/or the planarizing pad to rub the planarizing surface against the face of the substrate;

directing a first light pulse toward the face of the substrate, the first light pulse having a first color;

measuring a first intensity of a first return light pulse reflecting from the substrate, the first return light pulse having the first color;

directing a second light pulse toward the face of the substrate, the second light pulse having a second color different than the first color;

measuring a second intensity of a second return light pulse reflecting from the substrate, the second return light pulse having the second color;

comparing the first and second measured intensities with first and second reference components of sets of reference reflectances; and

controlling a parameter of the planarizing cycle of the substrate when the first and second measured intensities at least approximately correspond to the first and second reference components of a selected set of reference reflectances.

[c37] 37. The method of claim 36 wherein:

directing a first light pulse comprises emitting a red light pulse having a wavelength of approximately 600 nm to 780 nm; and

directing a second light pulse comprises emitting a green light pulse having a wavelength of approximately 490 nm to 577 nm.

[c38] 38. The method of claim 36, further comprising:

directing a third light pulse toward the face of the substrate, the third light pulse having a third color;

measuring a third intensity of a third return light pulse reflecting from the substrate, the third return light pulse having the third color; and

comparing the third measured intensity with a third component of the sets of reference reflectances.

[c39] 39. The method of claim 38 wherein controlling the parameter of the planarizing cycle comprises changing the parameter when the first, second and third measured intensities correspond to the first, second and third reference components of a selected set of reference reflectances.

[c40] 40. The method of claim 36 wherein controlling the parameter of the planarizing cycle comprises terminating the planarizing cycle when the first and second measured intensities correspond to the first and second reference components of an endpoint set of reference reflectances.

[c41] 41. A method of planarizing a microelectronic device substrate, comprising:

contacting a face of the substrate with a planarizing surface of a planarizing pad;

moving the substrate and/or the planarizing pad to rub the planarizing surface against the face of the substrate;

impinging a first light pulse against the face of the substrate at a first time interval, the first light pulse having a first color;

directing a second light pulse against the face of the substrate at a second time interval, the second light pulse having a second color;

sensing a first intensity of a first return light pulse corresponding to the first light pulse reflecting from the substrate and a second intensity of a second return light pulse corresponding to the second light pulse reflecting from the substrate; and

controlling a parameter of the planarizing cycle of the substrate according to the first and second intensities of the first and second return light pulses.

[c42] 42. The method of claim 41 wherein:

impinging a first light pulse comprises emitting a red light pulse having a wavelength of approximately 600 nm to 780 nm; and

directing a second light pulse comprises emitting a green light pulse having a wavelength of approximately 490 nm to 577 nm.

[c43] 43. The method of claim 41, further comprising:

directing a third light pulse toward the face of the substrate, the third light pulse having a third color;

measuring a third intensity of a third return light pulse reflecting from the substrate, the third return light pulse having the third color; and

controlling a parameter of the planarizing cycle comprises changing the parameter according to the first, second and third measured intensities.

[c44] 44. The method of claim 41 wherein controlling the parameter of the planarizing cycle comprises changing the parameter when the first and second

measured intensities correspond to a first reference component and a second reference component of a selected set of reference reflectances, respectively.

[c45] 45. The method of claim 41 wherein controlling the parameter of the planarizing cycle comprises terminating the planarizing cycle when the first and second measured intensities correspond to a first and a second reference component of an endpoint set of reference reflectances respectively.

[c46] 46. A microelectronic substrate assembly for use in controlling mechanical and/or chemical-mechanical planarization processes, comprising:

a substrate;

a first layer of a first material having first color, the first layer being disposed over at least a portion of the substrate, and the first layer having a first surface defining a desired endpoint elevation for a planarizing cycle;

a second layer of a second material disposed over the first layer, the second layer having a second color different than the first color; and

a sacrificial marker layer of a third material having a third color optically distinct from the first and second colors of the first and second materials.

[c47] 47. The microelectronic substrate of claim 46 wherein:

the first material comprises silicon nitride;

the second material comprises silicon dioxide; and

the third material of the sacrificial marker layer comprises an opaque resist material.

[c48] 48. The microelectronic substrate of claim 46 wherein:

the first material comprises silicon nitride;

the second material comprises silicon dioxide; and

the third material of the sacrificial marker layer comprises an optically transmissive material.

[c49] 49. The microelectronic substrate of claim 46 wherein:
the first material comprises silicon nitride;
the second material comprises silicon dioxide; and
the third material of the sacrificial marker layer comprises a red layer of material.

[c50] 50. The microelectronic substrate of claim 46 wherein:
the first material comprises silicon nitride;
the second material comprises silicon dioxide; and
the third material of the sacrificial marker layer comprises a black layer of material.

[c51] 51. The microelectronic substrate of claim 46 wherein:
the first material comprises silicon nitride;
the second material comprises silicon dioxide; and
the third material of the sacrificial marker layer comprises a white layer of material.